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ABSTRACT

The application of computer programing to construction of maps and geographic distributions of data has been called geocoding. This new use of the computer allows much more rapid analysis of various demographic characteristics. In particular, this paper describes the use of computer geocoding in the development of a plot of student density in Milwaukee, where school boundaries were being redrawn. The objective of redistricting was to solve school overcrowding and identify possible future boundaries for smaller school districts. The computer produced location grids which, when superimposed on conventional maps, allowed analysis of the school population on several variables, and hence more efficient redistricting. Such geocoding could have many possible applications in the study of other school demographic problems, such as the distribution of minority groups. (RB)

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APPLICATIONS OF GEOCODING AND MAPPING

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Historical Development of Geographic Data Bases and Computer Mapping

The use of geocoding and mapping is not new to educators. If geocoding- geographic coding- is defined as some symbolic code denoting a geographic location, then street addresses, census tract numbers, block numbers, and city and street names, all represent geocodes. The census bureau has always been reporting its statistics by geocodes-geographic reference points. What is of recent vintage is the use of geocodes on computer readable files for the purpose of utilizing the computer's great speed to perform tasks other than to merely tally data on the basis of the geocodes. In addition to the preparation of tallies, it was noted that characteristics of geographic areas could be converted to a computer readable format such that the computer could literally produce maps of areas or concentrations of characteristics. It is these two rather recent uses of the computer that provides the basis for this paper.

In October of 1968, Edward Ide presented a paper to the Association for Computing Machinery's Annual Symposium on the Application of Computers to the Problems of Urban Society. His paper was entitled "Address Coding to Produce Age-Race Data by City Blocks for School Planning". This paper dealt with a problem similar to that of Milwaukee namely the preparation of detailed geographical tabulations of school population.

Early Developments By The Census Bureau

Perhaps the more well known work done on geocoding and computer mapping techniques has been accomplished via the Census Use Study performed by the Bureau of the Census. These two techniques were investigated as part of the Census Use Study which was a small-area data research study sponsored by the Bureau of the

Census and performed in New Haven, Connecticut from September 1966 to July 1969. This study was established to explore the current uses and future needs of small-area data and data handling and display techniques in local, state, and federal agencies. The results of this study can be found in eleven different reports and three different computer packages all available by contacting the Department of Commerce, Bureau of the Census. (See Appendix)

Statement of the Problem

In the Fall of 1969 and the Spring of 1970, the Milwaukee Public Schools (MPS) was undergoing a period of rearrangement. By rearrangement, I mean that a number of attendance areas within the district were undergoing a careful scrutiny for the purpose of reviewing whether or not their redistricting was necessary. When the actual work got under way, the method used to plot student density was the tried and true "pin map" method. The obvious shortcoming to this approach, is that with a large school district such as Milwaukee, 130,000 + students, one either needs, many pins and pinstickers, or small geographic areas for plotting density, or both. Without one of these givens, it becomes such a horrendous task, that a recount of the data is impossible and a loss of pins a nightmare. This major undertaking in the 1969-70 school year was the problem whose need for a solution led to a search for the proverbial "better mousetrap," for future redistricting projects. Since one major project was already anticipated for the Spring of 1971, the improved method was needed quickly.

In June of 1970, Dr. Donald McIsaac, his staff, and members of the Milwaukee Public Schools' Division of Planning and Long-Range Development met for the first time to discuss Dr. McIsaac's proposal for converting our student file to a geographic data base. The work commenced in June of 1970 and continued into the

fall with the first piece of useable output available in November of 1970. Additional output was prepared with the project being completed in February 1971 and redistricting recommendations being submitted a few weeks later.

This system developed by Dr. McIsaac and his staff has been used in three major areas of concern at Milwaukee since its development. Each area of emphasis will now be reviewed.

Actual Applications in Milwaukee

School Redistricting

As mentioned previously, the first project utilizing the computer mapping system was one involved in redistricting. The objective of the redistricting project was to identify boundaries to solve the immediate problem of school overcrowding and to identify possible future boundaries for new smaller districts sometime in the future. The area under investigation was approximately six miles by four miles and consisted of land recently annexed by the city of Milwaukee. This area was to be divided into a number of elementary school districts to accomodate the three existing elementary schools acquired through annexation as well as the two elementary and one senior high planned to be built over the next five years. This area was of additional concern because of two very large housing developments which were under construction in the Fall of 1970 and expected to be providing students to the schools by 1971.

As mentioned earlier, the standard procedure would have been to prepare hand tallies or pin maps of the student population in the area and then prepare recommendations upon completion of the analysis of the maps or tallies. The availability of the geo-coding system made the task somewhat easier.

The first step was to identify a student file which was satisfactory for geocoding. Two such files were available. One file was the MPS Student Data Bank - a centralized computer file containing a basic record on all pupils in the MPS. This file was not used since it was felt that data on pre-school students were also needed but was not available in this file.

The file chosen was that which is available from the annual Student Census. The Milwaukee Public Schools is charged by state statute with the responsibility of taking an annual census of all children living within the area to be served by Milwaukee Public Schools. The final census tallies are prepared by processing a mark sense card which is prepared for every child counted in the census. This card contains the child's age (0-18), sex, type of school attended (private or public, none), and the home address of the student. This card is then converted to a punched card format and put into a reel of magnetic tape for report generation and later storage. It was this student census file which was converted to a geocoded data base and then used to produce a location grid.

A number of such grids were produced including grids which grouped children by age into probable school attendane type - pre-school, elementary, junior high and senior high. These grids were prepared at a scale consistent with some maps specifically prepared for MPS. Since the location grids are prepared on transparent paper, it was possible to overlay the grids onto the maps, and begin analyzing the pupil density by age, type of school attendance, or geographic location by either changing and then comparing grids or by hand counting the various tallies.

The only drawback to this system, is that which occurs if the scale is too small. When the scale is small, the tallies are prepared on such a large real geographic area that when the tallies are displayed, the value may appear in a geographic area which has no homes at all. When this occurs, the analyst must call upon his knowledge of the area to determine the probable allocation of the students used in the development of the figure.

As an example see Figure 1. Suppose the area found south of Tom Road but east of 86th Street is a cemetery but there are houses on the north side of Tom Road and on all other streets pictured in the map. Should the scale be made too small, it is possible through coincidence for all of the students found in the area bounded by that map to appear to be referenced to block number 604. With the figure appearing in the cemetery, the untrained observer will assume that an error has been made and thus treat the results with suspicion. Aside from this minor, though correctable situation, the system performed quite well.

The advantages are:

a. Should one wish to analyze a specific area more closely, it is a simple matter once the data base has been constructed, to request new plots at a larger scale. This type of request would not be as simple using a pin map.

b. Because of the computer's speed, it was possible to scrutinize the student population in the districts surrounding the area of interest with little additional effort. Developing location grids for relatively large areas is very easy using the speed of the computer as opposed to the effort of preparing additional pin-maps.

While this would have been necessary under any circumstance, it was much easier to tally the 16,000 + students within the area as well as the 2 or 3 thousand additional students in the surrounding area via this method as opposed to using additional pin stickers.

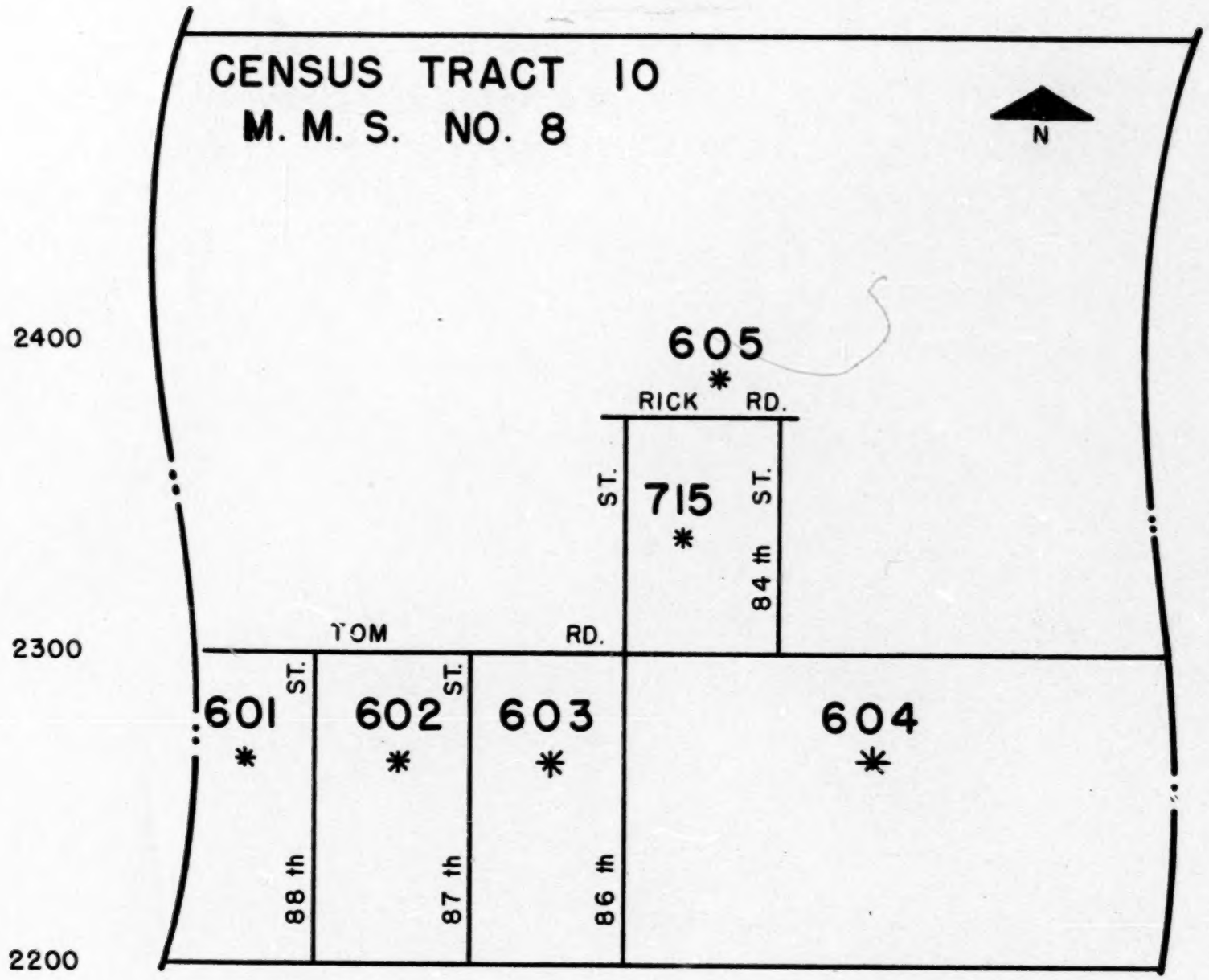

CENSUS TRACT 10
M. M. S. NO. 8
N
2400
605
RICK RD.
715
ST.
ST.
84 th
TOM RD.
2300
601
602
603
604
ST.
ST.
88 th
87 th
86 th
2200

FIGURE 1

Identification of Title I Areas

".....The proposal must of necessity include the determination of what constitutes the eligible Title I area, and within those areas which schools reflect the greatest economic deprivation." If you are from a district using E.S.E.A. Title I money, you will probably recognize this statement, for you know that the schools should be reclassified each year. The solution to this problem was somewhat similar to a solution described earlier. As before, the appropriate file needed to be located, geocoded, and then tallies prepared for each geographic area.

The Title I guidelines recommend that local districts utilize Federal Census Data where possible. For 1971, the Fourth Count Summary Tape had not yet been released and so economic data was not available. Population and Housing characteristics which might relate to poverty were employed where possible, but it was still desireable to locate appropriate economic data. The data available were from the local A.F.D.C. Files. These data were utilized in previous years for the same purposes. In 1970, it took over six man weeks to tally the 15,000 A.F.D.C. records via the pin map approach. In actual man days, it took almost as long in 1971 with the new computer system, but now we were processing in excess of 24,000 records.

This being the first time that the geocoding system was tested on the entire city, additional time was needed to thoroughly review the system's performance. While the system's conceptual design indicated that it <u>should</u> work, in fact, some minor technical problems were encountered which required some minor reprogramming and modifications and yet the project was completed 1 man-month earlier than the previous activities.

After the A.F.D.C. data were geocoded, location grids were prepared at an appropriate scale permitting tallies to be made by school district. The only shortcoming to this method, was the previously mentioned problem of having a tally appear on the plot such that it appears to have children living in areas which have no housing. This problem was resolved by using a larger scale. In addition to the location grid, a contour map was drawn so as to develop a more graphic picture of the concentration of pupils being counted. Both the contour map and the location grids were used by members of the MPS Title I staff to explain the procedures used in Title I school identification to members of the Title I Parents Advisory Council. This year unlike years past, though there were criticisms of the final list, there was no real criticism of the method used to place schools on the list. While that sentence may seem to lack logic, what is meant is that they approved the decision-making process, it was the <u>decision</u> coming from the process which wasn't liked.

It is anticipated that this computer mapping will again be used in 1972 for the new reclassification of Title I Schools.

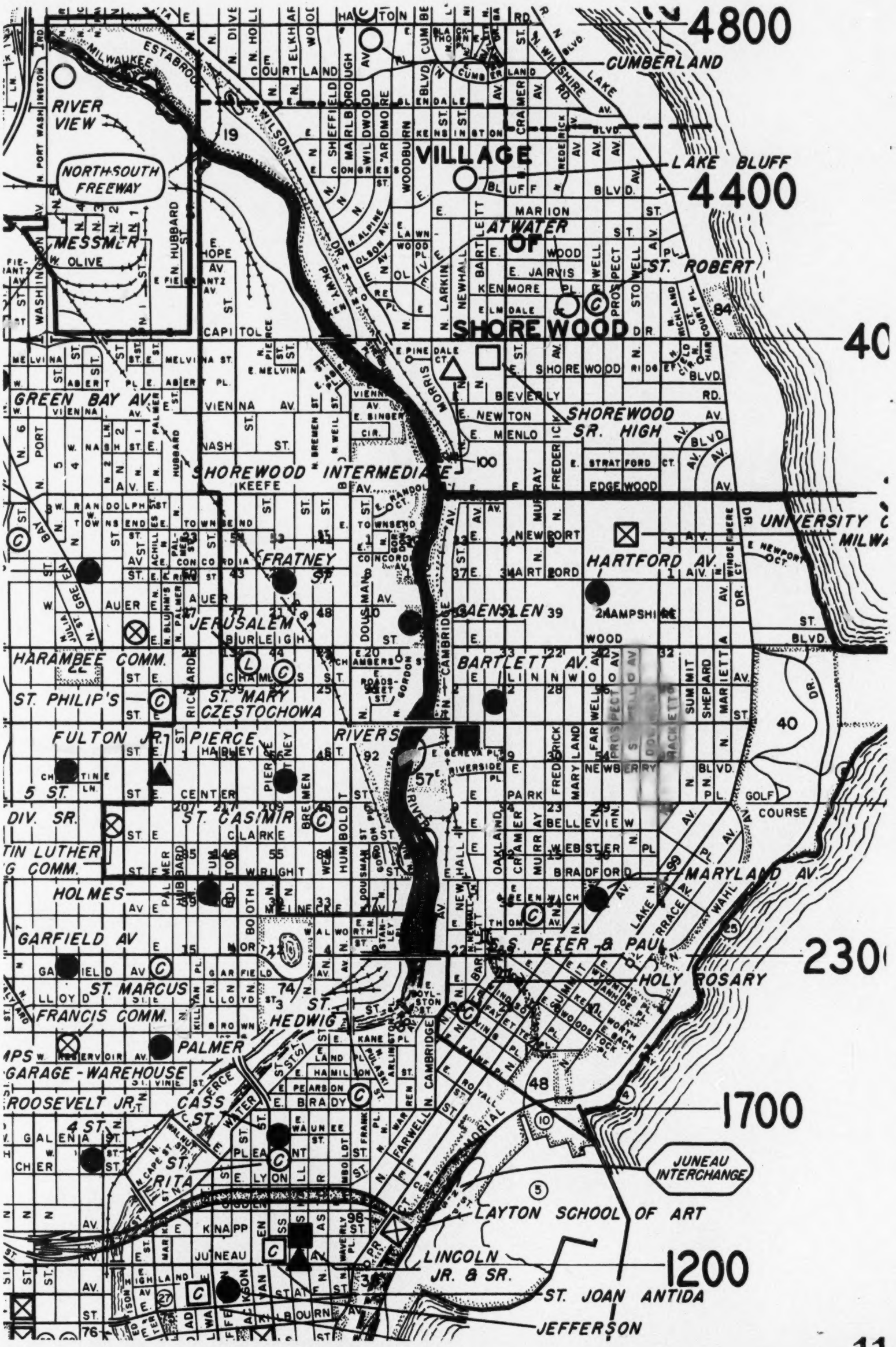
<u>The Capital Improvements Program</u>

The last and most current use of the computer mapping program has been to develop supporting data for school resource teams and members of the local school community in their development of recommendations supporting new school construction. One of the responsibilities of the Division of Planning and Long-Range Development is to provide demographic data to the resource teams. One of the most frequent requests by the resource team is for data concerning the school's future population. Though forecasts of the potential population are possible,

through the use of enrollment projections the mapping and geo-coding system being disucssed offers a more dynamic method of forecasting populations. The standard enrollment projection techniques assume fixed school boundaries. By using the location grids previously discussed, it is possible to analyze the possible effects on the future school population through redistricting. Because of this capability, in addition to the demographic data available through the 1970 census, the school resource teams also request location grids of the potential student population in the present school boundary as well as all contiguous districts. Invariably, the members of the team who haven't used these grids before are extremely pleased with there usefulness. This satisfaction is expressed even when it does nothing more than confirm their intuitive feelings about the area.

The following map and location grid will serve as an example of its use in this area. You will note that the river runs right through the district and yet from a cursory view of the values, you'll also note that most of the school population lives west of the river. Prior to the grid plot, members of the community expressed interest in expanding the school's northern and southern boundaries but making the river serve as the western boundary. A look at the data values indicates that the northern and southern boundaries would have to be extended a great distance to make up for the large number of students which could be served by simply extending the western boundary a few blocks.

As an additional note, the values which are circled, exemplify the phenomenon described earlier where data values appear in erroneous positions. Obviously no one lives in the river, but rather near enough to it so that when the value is printed, it <u>appears</u> in the river.


4800
CUMBERLAND
LAKE BLUFF
4400
4000
3700
1700
1200
RIVER VIEW
NORTH-SOUTH FREEWAY
MESSMER
VILLAGE
ATWATER
OF
ST. ROBERT
SHOREWOOD
SHOREWOOD SR. HIGH
SHOREWOOD INTERMEDIATE
GREEN BAY AV.
CAPITOL
KEEFE AV.
FRATNEY ST.
JERUSALEM
HARAMBEE COMM.
ST. PHILIP'S
ST. MARY CZESTOCHOWA
FULTON JR.
PIERCE
RIVERS
5 ST.
DIV. SR.
ST. CASIMIR
HOLMES
GARFIELD AV
ST. MARCUS
ST. FRANCIS COMM.
ST. HEDWIG
PALMER
GARAGE - WAREHOUSE
ROOSEVELT JR.
CASS ST.
4 ST.
ST. RITA
GAENSLEN
BARTLETT AV.
HARTFORD AV.
UNIVERSITY
MILWA
MARYLAND AV.
S. PETER & PAUL
HOLY ROSARY
JUNEAU INTERCHANGE
LAYTON SCHOOL OF ART
LINCOLN JR. & SR.
ST. JOAN ANTIDA
JEFFERSON
WILSON DR.
LAKE DR.
GOLF COURSE
MILWAUKEE
ESTABROOK
CUMBERLAND LAKE
WILLSHIRE RD.
MARION ST.
WOOD ST.
JARVIS
KENMORE PL
DALE
NEWHALL
LARKIN
ALPINE
WOODBURN
WILDWOOD
SHEFFIELD
MARLBOROUGH
ELKHART
COURTLAND
HOLLYWOOD
DIVERSEY
PORT WASHINGTON
HUBBARD ST.
OLIVE
HOPE AV.
CAPITOL
PIERCE
MELVINA ST.
ABERT PL.
VIENNA AV.
NASH ST.
KEEFE AV.
BAY ST.
RANDOLPH ST.
TOWNSEND
CONCORDIA
AUER
BURLEIGH
CHAMBERS
ROOSEVELT
CENTER
CLARKE
WRIGHT
MAINE
LLOYD
BROWN
KILLIAN
RESERVOIR AV.
VINE
GALENA ST.
CHERRY
KNAPP
JUNEAU
LOCUST
WALNUT
CAPE ST.
WATER
PLEASANT
LYON
HAMILTON
KANE PL
PEARSON
BRADY
WAUNEE
FARWELL
CAMBRIDGE
BREMEN
HUMBOLDT
DOUSMAN
GORDON
BOOTH
NEWHALL
BARTLETT
OAKLAND
CRAMER
MURRAY
BELLEVIEW
WEBSTER
BRADFORD
FREDERICK
MARYLAND
FARWELL
PROSPECT
STOWELL
SUMMIT
SHEPARD
MARIETTA
BRICKWOOD
NEWBERRY
PARK
RIVERSIDE
GENEVA PL
BEVERLY
NEWTON
MENLO
STRATFORD CT.
EDGEWOOD
NEWPORT
WOODS
SUMMIT
WAHL
LAKE
RACE
WYOMING
KENILWORTH
EDGEWORTH
BACKTOCK PL
HIGHLAND
CHELSEA
HARVARD
COURT PL.
EIFFEL
MORRIS
PINE DALE CT.
VIENNA
SINGER CIR.
BREMEN
WEIL
PALMER
HUBBARD
PULASKI
ARLINGTON
FRANKLIN
WARREN
MORGAN
WAUNEE
WAVERLY PL
HIGHLAND
ALLEN
JEFFERSON
ROYALL
MEMORIAL
WINDEMERE
NEWPORT CT.
HARTFORD
SHEPARD
MARIETTA
SUMMIT
BRICKWOOD
FREDERICK
MURRAY
CRAMER
OAKLAND
BARTLETT

Relevant Literature on the Topic of Geocoding

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5. Ide, Edward A., "Address Coding to Produce Age-Race Data by City Block For School Planning". Paper presented at the Association For Computing Machinery-Annual Symposium on the Application of Computers to the Problems of Urban Society, October 18, 1968.

6. Leyland, George, "The Ecological Problem in Small Area Data".
   Unknown

7. U. S. Department of Commerce-Bureau of the Census. Conference Proceedings November 1970, Wichita, Kansas on Use of Address Coding Guides in Geographic Coding--Case Studies. Washington: Government Printing Office, 1970.

8. U. S. Department of Commerce-Bureau of the Census. Conference Proceedings April 1-2, 1971, Jacksonville, Florida, on Geographic Base Files--Plans, Progress, and Prospects. Washington: Government Printing Office, 1970.

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   a. Reports
      1. General Description.
      2. Computer Mapping.
      3. Data Tabulation Activities.
      4. The DIME Geocoding System.
      5. Data Interests of Local Agencies.
      6. Family Health Survey.
      7. Health Information System.
      8. Data Uses in Health Planning.
      9. Data Uses in Urban Planning.
      10. Data Uses in School Administration
      11. Area Travel Survey.
      12. Health Information System-II.
      13. Computer Resource Allocation Model (CRAM).
      14. Geocoding with ADMATCH-A Los Angeles Experience.

b. Computer Program Packages.

1. ADMATCH: An Address Matching System. A computer program package designed for use in assigning geographic codes to local records using a DIME or similar geographic base file. Includes a users manual and computer programs.

2. DIME: A Geographic Base File System. A computer program package for creating a DIME geographic base file. Includes clerical instruction, a computer manual, and programs.

3. GRIDS: A Computer Mapping System. A computer program package for use on small-scale computers which provides three mapping options within a grid pattern: density, shading, and value maps. Includes users manual and computer programs.